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PENSOFT

Confirming the presence of a fourth species of non-native house gecko of the genus *Hemidactylus* Oken, 1817 (Squamata, Gekkonidae) in Colombia

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Abstract

The Indo-Pacific Gecko, *Hemidactylus garnotii* Duméril & Bibron, 1836, is a species of house gecko native to South-east Asia and Pacific Islands. As with many of its congeners, this gecko species has been accidentally introduced to other parts of the world. In January 2018, several photographs of "*H. frenatus*" from Colombia posted in iNaturalist.org, were noticed to have some morphological features related to *H. garnotii*. This discrepancy led us to inspect museum specimens and to confirm the presence of *H. garnotii* for more than a decade in Colombia.

Key words

Hemidactylus garnotii, *Hemidactylus frenatus*, introduced species, range expansion.

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Introduction

In recent decades, invasive alien species have become a global environmental issue of concern. The introduction of non-native species may severely damage economies and ecosystems (McNeely et al. 2001, Lockwood et al. 2013). Although humans have helped transfer organisms to non-native areas since ancient times, the rate has recently been increasing as a result of anthropogenic movements, especially related to commerce (Hulme 2009). Once introduced species have established, they are not being easily controlled or managed. Therefore, prevention, early detection and rapid response to invasive alien species are essential (Simpson et al. 2011).

The family Gekkonidae is one of the most diverse and widely distributed families of reptiles in the world, occurring throughout the tropic and temperate regions (Vitt and Caldwell 2014). Within this family, there is a cosmopolitan genus *Hemidactylus*, commonly known as house geckos (or salamanquejas in Spanish). Many species in this genus have spread beyond their natural distribution ranges with human aid, mostly accidentally (Carranza and Arnold 2006). In the Americas, they are records of 7 introduced species from this genus: *H. angulatus*, *H. frenatus*, *H. mabouia*, *H. garnotii*, *H. turcicus*, *H. platyurus*, and *H. parvimaculatus* (Carranza and Arnold 2006, Caidedo-Portilla and Dulcey-Cala 2011, Meshaka 2011, Ribeiro-Júnior 2015, Erdmann 2017), of which only the first 3 have been confirmed as established in Colombia (Caidedo-Portilla and Dulcey-Cala 2011).

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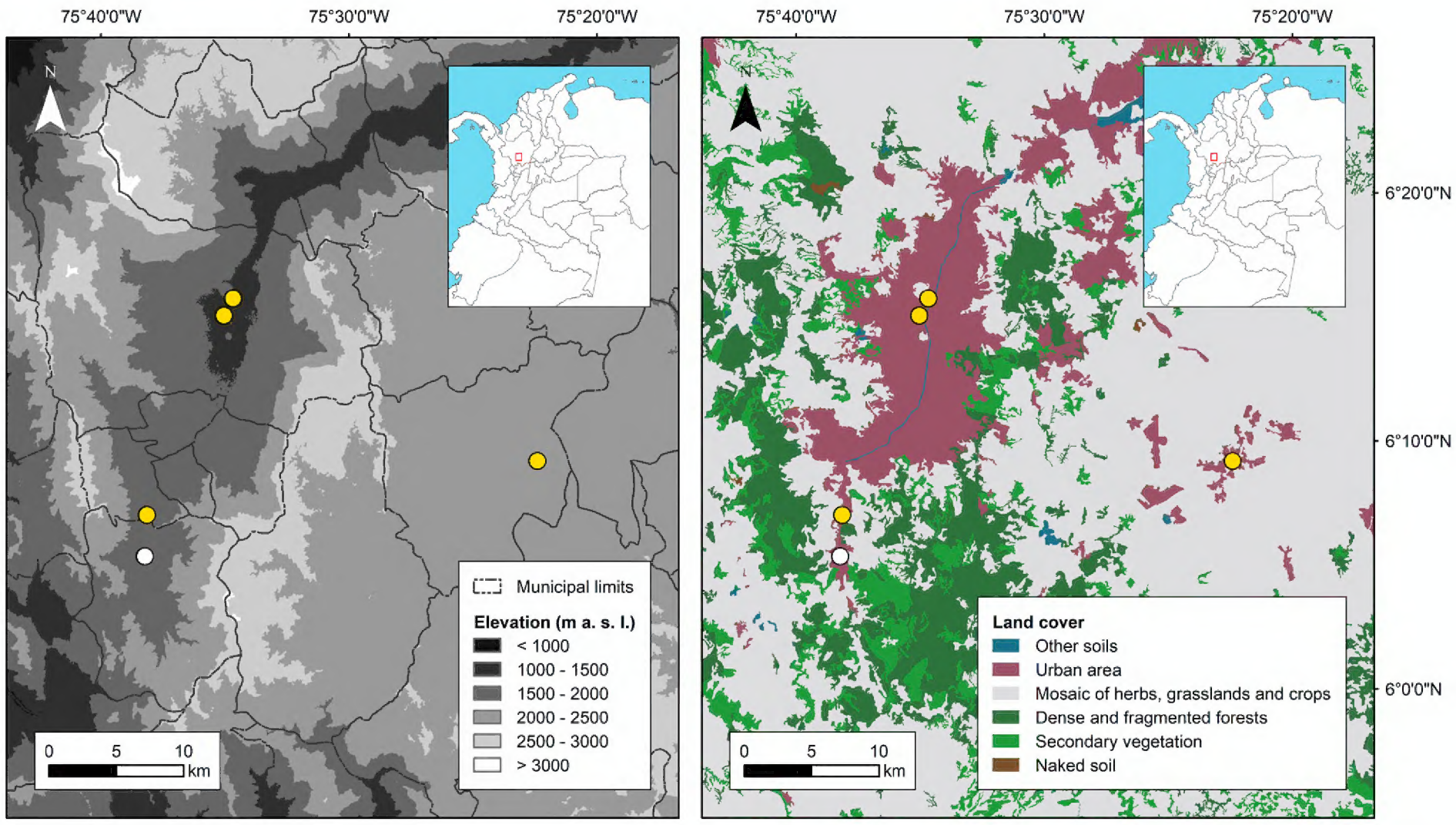

Figure 1. Records of *H. garnotii* in Colombia. Yellow circles: records with voucher specimens in a biological collection; white circle: personal observations confirmed (from the municipality of Caldas, Antioquia; JDV-R pers. obs.). Both maps show the same geographical area but with different base information, altitudinal gradient on the left and land cover on the right. Notice that records of *H. garnotii* are only know from urban areas.

During January 2018, we consulted iNaturalist.org (a collaborative naturalist network platform, https://www.inaturalist.org) for records of *H. frenatus* around the world as part of a study of its invasion history. We noticed unusual features in some photographs of Colombian specimens, not related to *H. frenatus*, including depressed bodies, flattened tails with serrated margins, and pronounced calcium deposits on the necks. We suspected that those geckos were actually *H. garnotii*, even though it had never been recorded in Colombia. Because the identification of species based on photographs often is not reliable, we consulted specimens in the reptile collection of the Museo de Herpetología Universidad de Antioquia for a more detailed investigation.

Hemidactylus garnotii is a triploid all-female species of gecko, native to southeast Asia (Kluge and Eckardt 1969). Phylogenetically, *H. garnotii* is closely related to *H. platyurus*, *H. bowringii*, and *H. karenorum* (Carranza and Arnold 2006). However, *H. garnotii* is morphologically similar to, and often misidentified as *H. frenatus* (Kluge and Eckardt 1969).

Methods

We examined all specimens of the genus *Hemidactylus* (*n* = 38) deposited in the reptile collection of the Museo de Herpetología Universidad de Antioquia (MHUA). Morphological species identifications were based on Krysko and Daniels (2005) and Caidedo-Portilla and Dulcey-Cala (2011). The examined characters were: the extension of subdigital lamellae of the digit IV; the size, shape and arrangement of dorsal scales; the disposition of the second pair of chin shields; and the tail scutellation pattern.

Results

Of the 38 individuals examined (see Appendix), 20 corresponded to *Hemidactylus angulatus*, 13 to *H. frenatus*, and 5 to *H. garnotii*, these latter constituting the first verifiable records for this species in Colombia.

New records. Colombia: Antioquia. Medellín, Loma de los Bernal (06°15′00″ N, 075°35′00″ W; 1650 m a.s.l.), collected by Vivian Páez in 2004 (MHUA-R 11124; previously identified as *Hemidactylus frenatus* by Caidedo-Portilla and Dulcey-Cala 2011). Medellín, Universidad Nacional de Colombia (06°15′41″ N, 075°34′38″ W; 1470 m a.s.l.), collected by Wilmar Múnera in 2010 (MHUA-R 12269 and 12270). Rionegro, near the main plaza (06°09′10″ N, 075°22′21″ W; 2088 m a.s.l.), collected by Freddy Grisales on August 9, 2015 (MHUA-R 13031). La Estrella [originally reported in error as Caldas, JDV-R pers. comm.], in the city [corregimiento de La Tablaza, JDV-R pers. comm.] (06°06′57″ N, 075°38′05″ W; 1716 m a.s.l.), collected by Beatriz Rendón-Valencia on February 2, 2017 (MHUA-R 13250).

The new records were comprised of 1 published record that had been misidentified and 4 unpublished museum records. The geckos were collected in 3 separate localities, all in the Cordillera Central (Fig 1).

Identification. Examined specimens of *Hemidactylus garnotii* have (vs other Colombian species in parenthe-

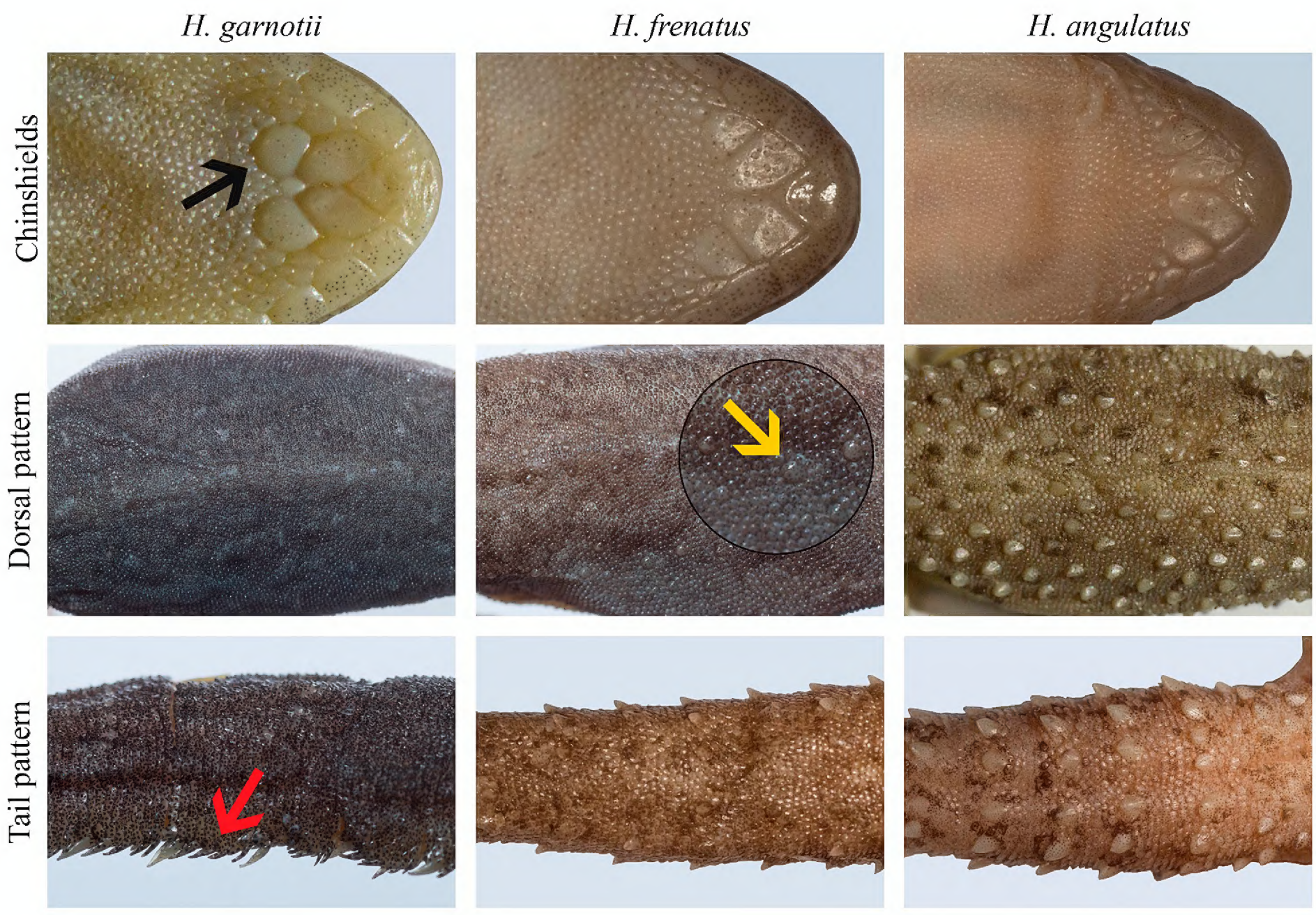

Figure 2. Morphological differences among *Hemidactylus garnotii* (MHUA-R 11124), *H. frenatus* (MHUA-R 11485), and *H. angulatus* (MHUA-R 10966) (chin shields, and dorsal and caudal scale arrangements). Black arrow: second pair of chin shields not in contact with infralabials in *H. garnotii*; yellow arrow: dorsal flat tubercles in *H. frenatus*; red arrow: serrated tail margin in *H. garnotii*.

ses): 1) second pair of chin shields not in contact with infralabials (vs second pair of chin shields in contact with infralabials, in *H. frenatus*, *H. angulatus*, and *H. mabouia*); 2) dorsal surface of the body with small granular scales, homogenous in size and shape (vs dorsal surface of the body with scales heterogeneous in size and shape, small granular scales intermixed with large conical tubercles in *H. angulatus*, and small granular scales intermixed with flat tubercles in *H. frenatus* and *H. mabouia*); 3) flattened tail with serrated margins, without dorsal spine-like or tubercles (vs cylindrical tail without serrated margins, with dorsal spine-like or tubercles in *H. angulatus*, *H. frenatus*, and *H. mabouia*) (Fig. 2); 4) subdigital lamellae of digit IV extending to the base of digit (vs subdigital lamellae of digit IV not extending to the base of digit, in *H. mabouia*) (Fig. 3); and 5) dorsal coloration without chevron marks (vs dorsal coloration with darker chevron marks, in *H. mabouia*). Additionally, 4 of the 5 individuals of *H. garnotii* (all except a juvenile) had 2 hardened ball-like structures (calcium deposits) on the neck, which are often, but not always found in *H. garnotii*.

Discussion

The museum records confirm that *Hemidactylus garnotii* has been introduced into Colombia for at least the past 14 years, and due to its similarity with *H. frenatus,* it has been misidentified and thus overlooked. Interestingly, specimens of *H. frenatus* were also misidentified as *H. angulatus* or *H. mabouia* (Caidedo-Portilla and Dulcey-Cala 2011). Presumably, non-native species may go undetected for years after their introduction, because local biologists are still unfamiliar with those taxa. Images with diagnostic characters of those species provided in our study may help now identifications of *Hemidactylus* specimens in Colombia.

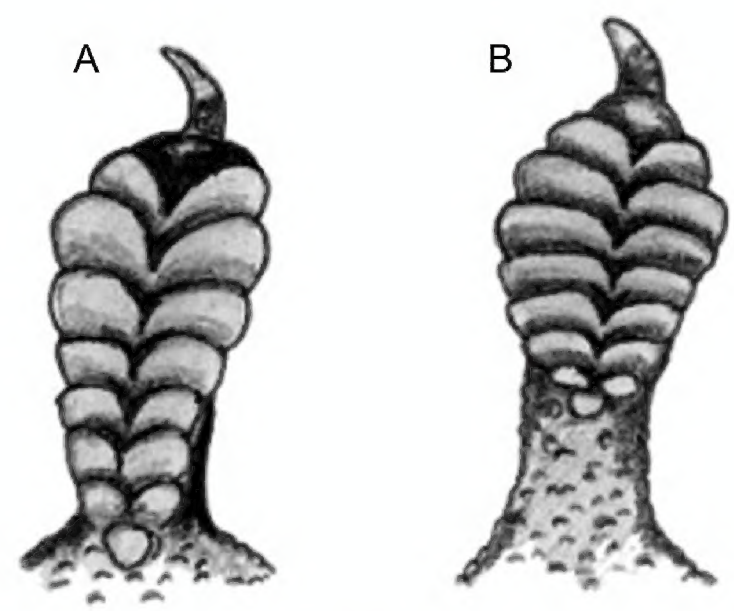

Figure 3. Morphological differences of subdigital lamellae of digit IV within *Hemidactylus*. **A.** Subdigital lamellae extending to the base (as in *H. angulatus*, *H. frenatus*, and *H. garnotii*). **B.** Subdigital lamellae not extending to the base (*H. mabouia*). Figure taken and adapted from Krysko and Daniels (2005: fig. 2).

Baptiste and Múnera (2010) reported *H. garnotii* in Isla de Salamanca, Ciénaga Grande de Santa Marta, department of Magdalena, Colombia, but Caidedo-Portilla and Dulcey-Cala (2011) suggested that this record was not reliable, due to the lack of voucher specimens in a biological collection, or other evidence that allowed confirmation of the validity of Baptiste and Múnera's observation. Therefore, our study is the first confirmed documentation of this species in Colombia, based on voucher specimens.

It is unclear of how *H. garnotii* was introduced to Colombia, or how far it has spread. However, we hypothesize that it might have been transported from Florida, USA, the largest known colony of this gecko in Americas (Meshaka 2011), as well as an important source of cargo shipments between North and South America, where the geckos could have arrived as stowaways.

Although *Hemidactylu*s geckos are abundant in regions with an anthropogenic influence, they still have low geographic representativeness in Colombian biological collections (SiB Colombia, http://datos.biodiversidad.co, data available to March 21, 2018). This may actually be due to the commonness and abundance of *Hemidactylus* in some regions, which generates false impression that they are also common in biological collections. We recommend that more attention should be given to common but non-native specimens found in herpetological field samples, with the goal to try to add information about their distributions and dispersal capabilities.

Except for *Lepidodactylus lugubris* (JDV-R pers. comm.), it is currently unknown where in Colombia that *H. garnotii* occurs sympatrically with other gecko species. In Florida, USA, it occurs in sympatry with other house gecko species, including *H. mabouia*, *H. turcicus*, and *H. frenatus* (Meshaka 2011). While populations of *H. garnotii* were usually outcompeted by *H. frenatus* (Bolger and Case 1992, Dame and Petren 2006), this species in turn displaced *H. turcicus* in some other localities (Meshaka 2011). Fortunately, there are still no reports of *H. garnotii* having a negative impact on native gecko species. However, as an alien species, the gecko has the potential to modify food webs, to alter ecosystem dynamics, to facilitate the arrival of other invasive species, and to serve as a vector for diseases and parasites (Kraus 2009, Kelehear 2013, Lockwood et al. 2013).

Lastly, we suggest a re-examination of the *Hemidactylus* specimens from Colombia housed in other biological collections, with the aim to enhance our knowledge of this genus in Colombia. Furthermore, ecological studies of *Hemidactylus* geckos are essential to quantify the impact of these introduced species on local ecosystems, and then their management.

Acknowledgements

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Authors' Contributions

JDV-R collected the data, examined the specimens and took the photographs; YL verified identifications; JDV-R and YL wrote the text.

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Appendix

Examined material. ***H. garnotii*:** MHUA-R 11124, 12269, 12270, 13031, 13250 (detailed information provided above). ***H. frenatus*:** Antioquia, Amalfi, El Encanto, Finca El Mango (6° 48′ 32″ N, 75° 9′ 5″ W; 1000 m a.s.l.), collected in 2001 (MHUA-R 10499); Bolivar, Mompós, San Nicolás, finca La Coqueta (09°08′27″ N, 074°38′43″ W; 10 m a.s.l.), collected in 2003 (MHUA-R 10946); Caldas, Norcasia, Embalse La Miel I (05°34′00″ N, 074°52′60″ W; 345 m a.s.l.), collected in 2003 (MHUA-R 11006); Antioquia, Puerto Triunfo, Doradal (05°56′01″ N, 074°43′04″ W; 261 m a.s.l.), collected in 2006 (MHUA-R 11483, 11485); Antioquia, road Doradal–Medellín (05°58′52″ N, 074°58′16″ W; 710 m a.s.l.), collected in 2006 (MHUA-R 11490); Atlántico, Puerto Colombia, Humedal de la Cantera (11°01′54″ N, 074°52′43″ W; 20 m a.s.l.), collected in 2007 (MHUA-R 11680); Antioquia, San Roque, Providencia (06°30′52″ N, 074°54′45″ W; 829 m a.s.l.), collected in 2009 (MHUA-R 12017); Antioquia, Medellín (06°15′51″ N, 075°34′10″ W; 1550 m a.s.l.), collected in 2009 (MHUA-R 12075); Antioquia, Guadalupe, Los Cedros (06°50′17″ N, 075°11′32″ W; 716 m a.s.l.), collected in 2013 (MHUA-R 12629); Valle del Cauca, Cali, Universidad del Valle (03°22′33″ N, 076°31′60″ W; 980 m a.s.l.), collected in 2013 (MHUA-R 12687); Santander, Cimitarra, Puerto Olaya, Termocentro (06°26′33″ N, 074°22′56″ W; 140 m a.s.l.), collected in 2012 (MHUA-R 12786); Antioquia, San Carlos, El Jordán (06°15′10″ N, 074°49′44″ W; 862 m a.s.l.), collected in 2016 (MHUA-R 13175). ***H. angulatus*:** Antioquia, Medellín, Universidad de Antioquia (06°15′51″ N, 075°34′10″ W; 1520 m a.s.l.), collected in 2000 (MHUA-R 10303); Antioquia, Medellín, Simon Bolivar neighborhood (06°15′00″ N, 075°34′60″ W; 1460 m a.s.l.), collected in 2000 (MHUA-R 10309); Antioquia, Caucasia (07°59′20″ N, 075°11′52″ W; 150 m a.s.l.), collected in 2001 (MHUA-R 10614, 10615); Antioquia, Caucasia, Hacienda La Leyenda (08°00′36″ N, 075°14′42″ W; 70 m a.s.l.), collected in 2002 (MHUA-R 10921); Antioquia, Medellín, Belén neighborhood (06°12′00″ N, 075°35′60″ W; 1500 m a.s.l.), collected in 2002 (MHUA-R 10950); Antioquia, Carepa, Corpoica (07°46′47″ N, 076°40′15″ W; 35 m a.s.l.), collected in 2003 (MHUA-R 10958, 10966, 10967, 10980, 10985); Caldas, Norcasia, Embalse La Miel I (05°34′00″ N, 074°52′60″ W; 345 m a.s.l.), collected in 2003 (MHUA-R 11005); Antioquia, Medellín, El Velódromo neighborhood (06°15′0″ N, 075°34′60″ W; 1500 m a.s.l.), collected in 2005 (MHUA-R 11403); Caldas, Victoria, Canan, Finca Guadual (05°19′09″ N, 074°55′48″ W; 902 m a.s.l.), collected in 2006 (MHUA-R 11430); Antioquia, Itagüí, El Tablazo (06°10′33″ N, 075°36′45″ W; 1630 m a.s.l.), collected in 2006 (MHUA-R 11442); Antioquia, Puerto Triunfo, Doradal (05°56′01″ N, 074°43′04″ W; 261 m a.s.l.), collected in 2006 (MHUA-R 11484); Meta, Villavicencio, Estación Roberto Franco (04°09′12″ N, 073°38′06″ W; 500 m a.s.l.), collected in 2008 (MHUA-R 11904); Antioquia, Medellín, Los Colores neighborhood (06°17′29″ N, 075°32′10″ W; 2114 m a.s.l.), collected in 2009 (MHUA-R 11974); Antioquia, Nariño, Puente Linda (05°34′09″ N, 075°07′26″ W; 655 m a.s.l.), collected in 2010 (MHUA-R 12063); Antioquia, Medellín, Universidad de Antioquia (06°16′03″ N, 075°34′06″ W; 1466 m a.s.l.), collected in 2011 (MHUA-R 12357).